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10/512,405

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MCLEAN, VA 22102

EXAMINER

DOLAN, JENNIFER M

ART UNIT

PAPER NUMBER

2813

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**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

## Office Action Summary

Application No.

10/512,405

Applicant(s)

TAKASE ET AL.

Examiner

Jennifer M. Dolan

Art Unit

2813

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

### Status

- 1) ☐ Responsive to communication(s) filed on \_\_\_\_.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

### Disposition of Claims

- 4) ☒ Claim(s) 1-17 is/are pending in the application.
- 4a) Of the above claim(s) \_\_\_\_ is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-17 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_ are subject to restriction and/or election requirement.

### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 25 October 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

### Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some \* c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

### Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☒ Information Disclosure Statement(s) (PTO/SB/08)  
Paper No(s)/Mail Date 3/16/05.

- 4) ☐ Interview Summary (PTO-413)  
Paper No(s)/Mail Date. \_\_\_\_.
- 5) ☐ Notice of Informal Patent Application
- 6) ☐ Other: \_\_\_\_.

## DETAILED ACTION

### *Claim Rejections - 35 USC § 112*

1. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

2. Claims 1-17 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Regarding claims 1, 3, 7, and 8 (all other claims by virtue of dependency), the inclusion of material within parentheses renders the claim indefinite because it is unclear whether these limitations are part of the claimed invention. For claims 1 and 3, since a BMD need not necessarily be an oxygen precipitate, it is unclear as to whether the claimed invention is limited to oxygen precipitates only, or whether other BMDs could be applied instead. For claims 1, 3, 7, and 8, the inclusion of (ASTM F-121, 1979) makes it unclear as to whether the claim specifically requires measurement of the oxygen concentration according to the method of the ASTM guidelines, or whether the (ASTM F-121, 1979) is merely an example of how the concentration could be measured.

For the purpose of examination, it is assumed that none of the material within the parentheses is an actual claim limitation, such that the BMD must be an oxygen precipitate, and the oxygen concentration need not be measured according to the ASTM guidelines.

Art Unit: 2813

Regarding claims 1-6, the claims recite a limitation of a density of  $1 \times 10^4/\text{cm}^2$  in the wafer. Since the specific density unit refers to a surface density and not a volume density, it is unclear as to how the specified density could refer to the volume article of a wafer. Thus, the Examiner is unclear as to whether claims 1 and 3 refer to a BMD density of  $1 \times 10^4/\text{cm}^3$  or more throughout the wafer, or whether the claims refer to a BMD density upon an outer surface of the wafer of  $1 \times 10^4/\text{cm}^2$  or more.

For the purpose of examination, it is assumed that the BMD density is  $1 \times 10^4/\text{cm}^3$  or more throughout the wafer

***Claim Rejections - 35 USC § 103***

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 1, 2, 5<sup>1</sup> and 6<sup>1</sup> are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,544,656 to Abe et al. in view of Japanese Patent Publication 10-150048 to Sueoka (cited by Applicant) and U.S. Patent No. 5,502,331 to Inoue et al. (cited by Applicant)

Abe discloses a high resistance silicon wafer and method for forming such a wafer (column 5, lines 45-57), the wafer having a resistivity of 100 ohm-cm or more (column 10, lines 55-58; figure 1), wherein an oxygen precipitate having a size of 0.2 microns or more (column 9, lines 10-16) is formed so as to have a high density throughout the wafer (column 9, lines 10-16), an oxygen concentration of  $12 \times 10^{17}$  atoms/cm<sup>3</sup> or less (column 11, lines 10-15; figure 2),

Art Unit: 2813

wherein a heat treatment process to form an oxygen precipitate nucleus and a heat treatment process for growing the oxygen precipitate on the primary silicon wafer are employed (column 13, lines 1-40; figure 3). Abe further indicates that for the specific ranges of oxygen concentration, the resistivities fall into the claimed ranges (see table 1 and figure 1), and that the disclosed method will result in a denuded zone layer formed in the surface of the wafer (column 8, lines 28-35)

Abe fails to teach a carbon concentration as claimed. Abe further fails to specify an oxygen precipitate density of exactly  $1 \times 10^4/\text{cm}^3$ , or the exact depth of the denuded zone

Sueoka teaches that inclusion of carbon having a concentration of greater than  $0.5 \times 10^{16}$  atoms/cm<sup>3</sup> (Sueoka, paragraphs 0010, 0013-0014) into a high resistivity silicon wafer including the oxygen precipitates in a manner similar to that in Abe (see Sueoka, paragraphs 0003-0004) will reduce occurrence of slip dislocations in the wafer (Sueoka, paragraphs 0033-0035).

Inoue indicates that high resistivity silicon wafers including methods similar to that in Abe (Inoue, columns 3-4) can result in BMD densities in a range encompassing the claimed value (see Inoue, column 2, lines 18-25, column 3, lines 40-42). Inoue also indicates that the denuded zone is about 10 microns deep (Inoue, column 1, lines 53-55), and that the method results in LPDs having a total surface density of less than  $0.06/\text{cm}^2$  (see table 2).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the wafer of Abe, such that it includes carbon at the specified concentration, as suggested by Sueoka, and such that the BMD density is  $1 \times 10^4/\text{cm}^3$ , with a denuded zone of greater than 5 microns and a LPD in the range specified, as suggested by Inoue. The rationale is

Art Unit: 2813

as follows: A person having ordinary skill in the art would have been motivated to include carbon at the specified concentration, because Sueoka shows that inclusion of carbon will reduce the occurrence of slip dislocations in the wafer, thus improving the quality and yield for the wafers (Sueoka, paragraph 0007). It is further obvious to specify a BMD density falling in the range of  $5 \times 10^2/\text{cm}^3$ - $5 \times 10^6/\text{cm}^3$ , a denuded zone of 10 microns, and an LPD density less than the claimed limit, because Inoue indicates that the presence of a large density of BMD defects within the 10 microns from the surface of the wafer and LPDs on the surface of the wafer lead to defective failure in the devices produced on the wafer, decreased yield, and increased breakdown and failure rates (see Inoue, table 2, column 1, lines 60-67; column 4, lines 25-37, column 5, lines 10-20 and 40-54). Although none of the applied references specifically teach a value of  $1 \times 10^4/\text{cm}^3$ , it has been held that "where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235 (1955).

5. Claims 3, 6<sup>3</sup>, 8, 9<sup>8</sup>-12<sup>8</sup>, 15<sup>8</sup>, and 16<sup>8</sup> are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 6,544,656 to Abe et al. in view of Japanese Patent Publication 2001-217251 to Muroi et al. (cited by Applicant).

Regarding claims 3, 6<sup>3</sup> and 8, Abe discloses a high resistance silicon wafer and method for forming such a wafer (column 5, lines 45-57), the wafer having a resistivity of 100 ohm-cm or more (column 10, lines 55-58; figure 1), wherein an oxygen precipitate having a size of 0.2 microns or more (column 9, lines 10-16) is formed so as to have a density of  $1 \times 10^4/\text{cm}^3$  or more throughout the wafer (column 9, lines 10-16), an initial oxygen concentration of about 12.5 x

Art Unit: 2813

$10^{17}$  atoms/cm<sup>3</sup> (column 11, lines 15-35), and a final oxygen concentration of less than  $12 \times 10^{17}$  atoms/cm<sup>3</sup> (column 11, lines 10-15; figures 1- 2), wherein a heat treatment process to form an oxygen precipitate nucleus and a heat treatment process for growing the oxygen precipitate on the primary silicon wafer are employed (column 13, lines 1-40; figure 3). Abe further indicates that for the specific ranges of oxygen concentration, the resistivities fall into the claimed ranges (see table 1 and figure 1).

Abe is silent as to a density of a grown-in defect detected by seco etching. Abe further fails to specifically teach an initial oxygen concentration of  $14 \times 10^{17}$  atoms/cm<sup>3</sup> or more.

Muroi teaches that for a high resistance silicon wafer including oxygen precipitates (see paragraphs 0001-0002) as well as initial oxygen concentrations similar to that disclosed by Abe (see paragraph 0004) and including heat treatment processes similar to that of Abe (see paragraph 0005), it is expected that a density of a grown-in defect detected by seco etching is about  $1 \times 10^3$ /cm<sup>3</sup> would be detected (paragraph 0015). Muroi further indicates that an initial oxygen concentration of  $14 \times 10^{17}$  atoms/cm<sup>3</sup> or more is suitable for forming a low defect, high resistance silicon wafer (paragraphs 0004-0005).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify in the method of Abe that the density of a grown-in defect as measured by seco etching is about  $1 \times 10^3$ /cm<sup>3</sup>, as suggested by Muroi, and that the initial oxygen concentration is  $14 \times 10^{17}$  atoms/cm<sup>3</sup>, as suggested by Muroi. The rationale is as follows: A person having ordinary skill in the art would reasonably assume that since the initial conditions as well as methods in Abe and Muroi are similar, both to each other and to the methods disclosed by the Applicant, that similar grown-in defect densities would result from either method. Thus,

Art Unit: 2813

it is reasonably expected that the grown-in defect density as measured by seco etching for the device of Abe would fall within the claimed range. Alternately, it is expected that the methods of Muroi could be employed to ensure a low grown-in defect density, in order to improve the crystallinity of the wafer, and thereby decrease current leakage as well as improve optical characteristics of the wafer (see Muroi, paragraphs 0002, 0015). A person having ordinary skill would further utilize an initial oxygen concentration of  $14 \times 10^{17}$  atoms/cm<sup>3</sup>, since Abe indicates that the oxygen concentration is optimized to be sufficiently high to produce the desired density of oxide precipitates acting as getters, and sufficiently low that the wafer strength is not degraded (Abe, column 11, lines 25-40), and since Muroi further teaches that  $14 \times 10^{17}$  atoms/cm<sup>3</sup> is a suitable initial concentration (Muroi, paragraphs 0004-0005). Although Abe fails to specify a grown-in defect density and initial oxygen concentration as claimed, it has been held that "where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation." In re Aller, 220 F.2d 454, 456, 105 USPQ 233, 235 (1955).

Regarding claims 9<sup>8</sup>-12<sup>8</sup>, 15<sup>8</sup> and 16<sup>8</sup>, Abe further teaches that the heat treatment process sequentially includes an oxygen outward diffusion heat treatment at 1100 degrees C for 2 hours (first step in figure 3E); a RTA treatment in a nitrogen atmosphere at 1250 degrees C for 10 seconds (second step in figure 3E); a treatment for forming an oxygen precipitate nucleus at 800 degrees C for 4 hours (third step in figure 3E), and a heat treatment for growing the oxygen precipitate on the primary silicon wafer at 1000 degrees C for 16 hours (last step in figure 3E; also see table 1).



Art Unit: 2813

Abe fails to teach that the treatment for forming the oxygen precipitate occurs for 5 hours rather than 4 hours.

Muroi teaches that the treatment for forming the oxygen precipitate may last 5 hours (paragraph 0007).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the time for the oxygen precipitate forming heat treatment in Abe, such that it is 5 hours, as taught by Muroi. The rationale is as follows: A person having ordinary skill in the art would have been motivated to use a 5 hour long heat treatment, because Muroi shows that such a duration is suitable for forming the high quality, low defect wafer, and may generally be used interchangeably in place of a 4 hour duration (Muroi, paragraph 0007). It is further reasonably expected that a person having ordinary skill in the art would select a heat treatment duration through routine optimization, such that the time is sufficiently long to form the oxygen precipitate nucleus, but sufficiently short so as not to unduly increase the fabrication time of the wafer. Although Abe fails to specify a 5 hour long oxygen precipitate forming heat treatment, it has been held that “where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (1955).

6. Claims 4 and 17 are rejected under 35 U.S.C. 103(a) as being unpatentable over Abe et al. in view of Muroi et al. as applied to claims 3 and 8 above, and further in view of Sueoka.

Abe fails to teach inclusion of carbon at the specified concentration.

Sueoka teaches that inclusion of carbon having a concentration of greater than  $0.5 \times 10^{16}$  atoms/cm<sup>3</sup> (Sueoka, paragraphs 0010, 0013-0014) into a high resistivity silicon wafer including the oxygen precipitates in a manner similar to that in Abe (see Sueoka, paragraphs 0003-0004) will reduce occurrence of slip dislocations in the wafer (Sueoka, paragraphs 0033-0035).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the wafer of Abe as modified by Muroi, such that it includes carbon at the specified concentration, as suggested by Sueoka. The rationale is as follows: A person having ordinary skill in the art would have been motivated to include carbon at the specified concentration, because Sueoka shows that inclusion of carbon will reduce the occurrence of slip dislocations in the wafer, thus improving the quality and yield for the wafers (Sueoka, paragraph 0007).

7. Claims 5<sup>3</sup>, 13<sup>8</sup>, and 14<sup>8</sup> are rejected under 35 U.S.C. 103(a) as being unpatentable over Abe et al. in view of Muroi et al. as applied to claims 3 and 8 above, and further in view of Inoue et al.

Regarding claim 5<sup>3</sup>, Abe teaches that a denuded zone occurs in the surface of the wafer (column 8, lines 28-35), but fails to specify the depth of the denuded zone.

Inoue also indicates that the denuded zone is about 10 microns deep (column 1, lines 53-55).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify that the denuded zone in Abe as modified by Muroi is over 5 microns deep,

Art Unit: 2813

as suggested by Inoue. The rationale is as follows: A person having ordinary skill in the art would have been motivated to specify a sufficiently deep denuded zone depth, because Inoue indicates that the presence of a large density of BMD defects within the 10 microns from the surface of the wafer lead to defective failure in the devices produced on the wafer and decreased yield (see Inoue, column 1, lines 60-67; column 4, lines 25-37, column 5, lines 40-54).

Regarding claims 13<sup>8</sup> and 14<sup>8</sup>, Abe fails to teach performing the oxygen outward diffusion heat treatment in a nitrogen, hydrogen, argon, or mixed hydrogen/argon atmosphere.

Inoue indicates that hydrogen, argon, and nitrogen atmospheres may be employed for performing an oxygen outward diffusion heat treatment (column 1, lines 30-35, column 2, lines 40-41, column 3, lines 30-35 and 60-65).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify that the atmosphere for the oxygen outward diffusion heat treatment in Abe as modified by Muroi is formed of hydrogen, argon, or nitrogen, as suggested by Inoue. The rationale is as follows: A person having ordinary skill in the art would have been motivated to use hydrogen, argon, or nitrogen, since Inoue indicates that non-oxidizing atmospheres will decrease the surface BMD density and increase the interior BMD density (see Inoue, column 3, lines 25-65; table 1), thus resulting in a decrease in defective failure in the wafer devices as well as improved yield (see Inoue, column 1, lines 60-67, column 4, lines 20-25, column 5, lines 40-54). Since Inoue indicates that use of a mixed nitrogen/oxygen atmosphere is still superior to an oxygen atmosphere, alone (as in Abe; see Inoue, table 1, noting that the CZ column uses an oxygen heat treatment and the IG uses the nitrogen/oxygen treatment), it is apparent that even if

Art Unit: 2813

nitrogen is less desirable than hydrogen or argon, it still provides critical improvements over an oxygen atmosphere.

8. Claims 7, 11<sup>7</sup>, 12<sup>7</sup>, 15<sup>7</sup>, and 16<sup>7</sup> are rejected under 35 U.S.C. 103(a) as being unpatentable over Abe et al. in view of Sueoka.

Abe discloses a method for forming a high resistance silicon wafer (column 5, lines 45-57), the wafer having a resistivity of 100 ohm-cm or more (column 10, lines 55-58; figure 1), an initial oxygen concentration of  $12 \times 10^{17}$  atoms/cm<sup>3</sup> or more (see figure 2; column 11, lines 10-15, noting that 24-25 ppma corresponds to the claimed range), and a remaining oxygen concentration of less than  $12 \times 10^{17}$  atoms/cm<sup>3</sup> (column 11, lines 10-15; figure 1), wherein a heat treatment process to form an oxygen precipitate nucleus and a heat treatment process for growing the oxygen precipitate on the primary silicon wafer are employed (column 13, lines 1-40; figure 3).

Abe fails to teach a carbon concentration as claimed.

Sueoka teaches that inclusion of carbon having a concentration of greater than  $0.5 \times 10^{16}$  atoms/cm<sup>3</sup> (Sueoka, paragraphs 0010, 0013-0014) into a high resistivity silicon wafer including the oxygen precipitates in a manner similar to that in Abe (see Sueoka, paragraphs 0003-0004) will reduce occurrence of slip dislocations in the wafer (Sueoka, paragraphs 0033-0035).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the wafer of Abe, such that it includes carbon at the specified concentration, as suggested by Sueoka. The rationale is as follows: A person having ordinary skill in the art

Art Unit: 2813

would have been motivated to include carbon at the specified concentration, because Sueoka shows that inclusion of carbon will reduce the occurrence of slip dislocations in the wafer, thus improving the quality and yield for the wafers (Sueoka, paragraph 0007).

Regarding claims 11<sup>8</sup>, 12<sup>8</sup>, 15<sup>8</sup> and 16<sup>8</sup>, Abe further teaches that the heat treatment process sequentially includes an oxygen outward diffusion heat treatment at 1100 degrees C for 2 hours (first step in figure 3E); a RTA treatment in a nitrogen atmosphere at 1250 degrees C for 10 seconds (second step in figure 3E); a treatment for forming an oxygen precipitate nucleus at 800 degrees C for 4 hours (third step in figure 3E), and a heat treatment for growing the oxygen precipitate on the primary silicon wafer at 1000 degrees C for 16 hours (last step in figure 3E; also see table 1).

9. Claims 9<sup>7</sup> and 10<sup>7</sup> are rejected under 35 U.S.C. 103(a) as being unpatentable over Abe et al. in view of Sueoka, as applied to claim 7 above, and further in view of Muroi et al.

Abe fails to teach that the treatment for forming the oxygen precipitate occurs for 5 hours rather than 4 hours.

Muroi teaches that the treatment for forming the oxygen precipitate may last 5 hours (paragraph 0007).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to modify the time for the oxygen precipitate forming heat treatment in Abe as modified by Sueoka, such that it is 5 hours, as taught by Muroi. The rationale is as follows: A person having ordinary skill in the art would have been motivated to use a 5 hour long heat treatment, because Muroi shows that such a duration is suitable for forming the high quality, low

Art Unit: 2813

defect wafer, and may generally be used interchangeably in place of a 4 hour duration (Muroi, paragraph 0007). It is further reasonably expected that a person having ordinary skill in the art would select a heat treatment duration through routine optimization, such that the time is sufficiently long to form the oxygen precipitate nucleus, but sufficiently short so as not to unduly increase the fabrication time of the wafer. Although Abe fails to specify a 5 hour long oxygen precipitate forming heat treatment, it has been held that “where the general conditions of a claim are disclosed in the prior art, it is not inventive to discover the optimum or workable ranges by routine experimentation.” *In re Aller*, 220 F.2d 454, 456, 105 USPQ 233, 235 (1955).

10. Claims 13<sup>7</sup> and 14<sup>7</sup> are rejected under 35 U.S.C. 103(a) as being unpatentable over Abe et al. in view of Sueoka, as applied to claim 12<sup>7</sup> above, and further in view of Inoue et al.

Abe fails to teach performing the oxygen outward diffusion heat treatment in a nitrogen, hydrogen, argon, or mixed hydrogen/argon atmosphere.

Inoue indicates that hydrogen, argon, and nitrogen atmospheres may be employed for performing an oxygen outward diffusion heat treatment (column 1, lines 30-35, column 2, lines 40-41, column 3, lines 30-35 and 60-65).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to specify that the atmosphere for the oxygen outward diffusion heat treatment in Abe as modified by Sueoka is formed of hydrogen, argon, or nitrogen, as suggested by Inoue. The rationale is as follows: A person having ordinary skill in the art would have been motivated to use hydrogen, argon, or nitrogen, since Inoue indicates that non-oxidizing atmospheres will decrease the surface BMD density and increase the interior BMD density (see Inoue, column 3,

Art Unit: 2813

lines 25-65; table 1), thus resulting in a decrease in defective failure in the wafer devices as well as improved yield (see Inoue, column 1, lines 60-67, column 4, lines 20-25, column 5, lines 40-54). Since Inoue indicates that use of a mixed nitrogen/oxygen atmosphere is still superior to an oxygen atmosphere, alone (as in Abe; see Inoue, table 1, noting that the CZ column uses an oxygen heat treatment and the IG uses the nitrogen/oxygen treatment), it is apparent that even if nitrogen is less desirable than hydrogen or argon, it still provides critical improvements over an oxygen atmosphere.

### ***Conclusion***

11. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

US 2003/0068890 to Park and US 2003/0054641 to Binns et al. disclose high resistivity silicon wafers wherein heat treatment processes are used to decrease the oxygen precipitate concentration at the surfaces of the wafer.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Jennifer M. Dolan whose telephone number is (571) 272-1690.

The examiner can normally be reached on Monday-Friday 8:30am-5:00pm.


If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl W. Whitehead, Jr. can be reached on (571) 272-1702. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Art Unit: 2813

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Jennifer M. Dolan  
Examiner  
Art Unit 2813

jmd



CARL WHITEHEAD, JR.  
SUPERVISORY PATENT EXAMINER  
TECHNOLOGY CENTER 2800